AD-A190 347 AVAILABILITY OF PHOSPHORUS IN COW SLURRY USING ISOTOPIC LABELLING TECHNIQUE(U) RISOE NATIONAL LAB ROSKILDE (DENMARK) P PONGSAKUL ET AL. JAN 88 RISOE-R-557 1/1

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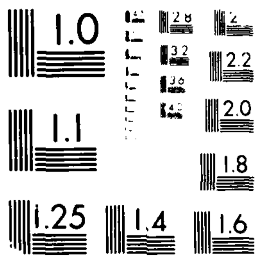
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Availability of Phosphorus in Cow Slurry Using Isotopic Labelling Technique

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Availability of Phosphorus in Cow Slurry Using Isotopic Labelling Technique

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Abstract. A pot experiment was conducted to evaluate the influence of cow slurry on P uptake by corn and to estimate the readily available P in the slurry by using an isotopic labelling technique. Water-soluble P in soil was increased and isotopic equilibrium of available P was attained after labelled slurry was mixed thoroughly throughout the soil. Labelled slurry applied at planting increased the P uptake by corn, whereas the same amount applied one week before harvest did not affect the P uptake. It was estimated that 46-54% of the total P uptake in plants is derived from the slurry. The readily available P (the L-value) in the slurry was at least 26 mg/kg which equals 3.7% of the total P.

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CONTENT

1. INTRODUCTION

Organic fertilizers, e.g., compost, green manure, farmyard manure, and farmyard slurry are not only important in improving the physical properties of soils but also provide mineral nutrients to plants. However, those nutrients in organic form must be mineralized before they are available to plants. Some organic fertilizers, especially farmyard manure and slurry, contain fairly large amounts of organic phosphorus (P), which must be mineralized before it can be utilized by plants.

For the efficient use of farmyard manure and slurry, however, it is very useful to know their content of readily available P in order to estimate the amount of fertilizer that should be applied to crops. L- and E-value determination are suitable techniques for evaluating available P if the mineralization and immobilization of P in the soil are low during the experimental period.

The aim of this experiment was to evaluate the influence of cow slurry on P uptake and to estimate the readily available P in the slurry by using ^{32}P.

2. MATERIALS AND METHODS

A pot experiment was conducted in a greenhouse during July-August 1987 at Risø National Laboratory, Roskilde, Denmark. The experimental design was a randomized complete block design with four replications. Treatments were 1) control (no cow slurry added), 2) ^{32}P-labelled slurry at rates of 125 and 250 g/pot applied at planting, and 3) the same amount of slurry applied a week before harvest.

Twenty litre pots were filled with 22 kg of sieved sandy loam which contained 0.14 mg/kg of water-soluble P and 11.0 mg/kg of $NaHCO_3$-extractable P. This soil had a pH of 7.8 in water. No basal fertilizers were added. Control pots received ammonium nitrate in the same amount of N as the NH_4-N content of the cow slurry (Table 1) to ensure that the plants obtained adequate amounts of N for their growth. Seven days before the first application to the soil the cow slurry was equilibrated with carrier-free ^{32}P as orthophosphate in 0.01M HCl at rates of 38.7 MBq per 125 or 250 g. The ^{32}P-labelled slurry applied at planting was mixed thoroughly throughout the whole 20 kg of soil whereas that applied later was supplied on the soil surface.

Ten seeds of 'Derby' corn (Zea mays L.) were sown in each pot. One week after planting, the plants were thinned to the five most vigorous per pot. Plants were harvested 30 days after seedling emergence. Plant tops were dried at 80°C for two days. Concentration of P and activity of ^{32}P in plant tops were determined by a chemical procedure and liquid scintillation, respectively. All activity figures (cps) in the following are corrected for decay. Water-soluble P and ^{32}P in slurry after labelling with carrier-free ^{32}P solution at the rate of 38.7 MBq per 250 g were determined at planting, 25 days after planting, and at harvest. Soil samples of each treatment were collected at 8, 15, 22 and 32 days after planting for determination of water--soluble P and ^{32}P to assess the specific activity of P.

Readily available P in the slurry was estimated by calculations of the percentage of P in the plant derived from the slurry according to the following equation (Ref. 2):

$$\text{Eq. 1: } P_{dff} = \frac{\text{specific activity of plant} \times 100}{\text{specific activity of soil supplied with slurry}}$$

where P_{dff} is P in the plant derived from the fertilizer (cow slurry) in per cent of total P in the plant.

3. RESULTS AND DISCUSSION

3.1. Labelling of cow slurry with ^{32}P

As seen in Table 2 the equilibrium between ^{32}P and available P in the cow slurry was not obtained, as the specific activity of P was not constant. The decrease in the specific activity indicate that some P was mineralized from organic P and some of the ^{32}P ay be immobilized by the high amount of microorganisms present in the slurry. In accordance with this result, Larsen (1967) noted that biological immobilization of P is significant if the microbial activity is boosted by addition of organic materials.

3.2. Effect of cow slurry on the availability of P in soil

Cow slurry obviously increased water-soluble P in soil (Table 3). This increase was due to the amount of available P in the slurry that was added to the soil. It should be noted that during 8 to 22 days after planting water-soluble P was slightly increased. This may be due to the mineralization of P from organic matter. The fact that some ^{32}P was sorbed by the soil and some was diluted by available soil P accounted for the lower specific activity of the soil P than that of the P in the slurry (Tables 2 and 4). However, the specific activity of ^{32}P in soil collected from the slurry treatments at different plant ages were not significantly different (Table 4) indicating that after labelled slurry was thoroughly mixed throughout the soil, the equilibrium of P was obtained. However, part of the explanation could be that the relative higher amount of carrier P, comming from the soil, and giving a lower specific activity, deminished the change in specific activity, too.

3.3. Dry matter production and P uptake by corn

Dry matter yields of corn plants supplied with cow slurry at planting were significantly higher than those of the control and of plants supplied with the slurry one week before harvest (Table 5). The growth of plants from the control and that of

plants receiving slurry at a later stage were limited by P nutrition.

Phosphorus concentration of plants receiving 250 g/pot of slurry at the time of planting was higher than those of other treatments (Table 5). Although the P concentration of plants receiving 125 g/pot of slurry at planting time was not higher than that of the control, the dry matter yield was higher, which means that the plants took up more P than the control. Phosphorus concentrations and uptake by the plants receiving both rates of slurry one week before harvest were similar to that of the control showing that surface-applied cow slurry did not contribute to the P supply of the plants during the one week.

3.4. Estimation of readily available P in cow slurry

By *assuming* that slurry had no effect on P availability in soil and using the first soil sampling (8 days after planting) from Table 3, the water-soluble P in soil derived from slurry in the 125 g/pot treatment was equal to 0.17 mg/kg (0.24 - 0.07).

Because the specific activity of soil supplied with slurry was 29 cps/µg P (Table 4), the specific activity of the slurry can be calculated to:

$$\frac{29 \times 0.24}{0.17} = 41 \text{ cps/µg P}$$

According to equation 1 and Table 6, P derived from the slurry is equal to:

$$\frac{19 \times 100}{41} = 46.3\%$$

P uptake from the 125 g/pot slurry treatment was 8.31 mg P/pot (Table 5), thus P in plant derived from the slurry was equal to:

$$\frac{8.31 \times 46.3}{100} = 3.8 \text{ mg/pot}$$

The amount of P in the slurry that was available to plants was:

$$\frac{3.8}{0.125} = 30.4 \text{ mg/kg slurry}$$

Because the total P of the slurry is 700 mg/kg (Table 1),

$$\frac{30.4 \times 100}{700} = 4.3\%$$

of the total P was readily available to the plant.

The same procedure was used to calculate P availability from the 250 g/pot slurry treatment. It was found that 53.8% of the P taken up by the plants was derived from the slurry, and the amount of slurry that was available to plants was 26 mg/kg slurry which equals 3.7% of total P in the cow slurry.

It can be concluded that 46-54 per cent of total P uptake in plants was derived from the cow slurry (Table 7). When P uptake and P added were used in calculating the readily available P, it was estimated that at least 26 mg P/kg slurry was available to plants (the L-value). This means that 3.7 per cent of the total cow slurry-P was present in a plant-available form.

4. REFERENCE

LARSEN, S. (1967). Soil phosphorus., Adv. Agron. 19, 151-210.

IAEA (1976). International Atomic Energy Agency. Tracer manual on crops and soils. IAEA-TR-171 (Vienna) 277 p.

Table 1. Some properties of cow slurry.

Properties	Concentration
Dry matter, %	8.91
pH	7.0
Total N, %	0.45
Ammonium N, %	0.26
Water-soluble P, mg/kg	49.4
Total P, mg/kg	700
Total K, %	0.44
Total Na, %	0.20
Total Ca, %	0.10
Total Mg, %	0.06
Total Cu, mg/kg	2
Total Mn, mg/kg	14
Total Zn, mg/kg	11

The cow slurry and the data in this table were supplied by the State Experimental Station at Askov.

Table 2. Specific activity of labelled cow slurry.

Sampling time	^{32}P	P	$^{32}P/P$
	cps/g	µg/g	cps/µg
At planting	6609	44.6	148
At 25 days after planting	2864	49.4	58
At harvest	1988	53.4	37

Table 3. Water-soluble phosphorus in soil as affected by application of labelled cow slurry.

Cow slurry treatment	Sampling time (days after planting)			
	8	15	22	32
	µg g			
None added	0.07	-[1]	-	0.06
125 g pot, applied at planting	0.24	0.34	0.36	0.13
250 g pot, applied at planting	0.43	0.50	0.57	0.22
125 g pot, applied 1 week before harvest	-	-	-	0.16
250 g pot, applied 1 week before harvest	-	-	-	0.26

[1] Not determined.

Table 4. Specific activity of soil supplied with ^{32}P-labelled cow slurry.

Sampling time	Cow slurry treatment	
	125 g/pot	250 g/pot
	$^{32}P/P$ (cps/µg)	
At 8 days after planting	29	22
At 15 days after planting	20	14
At 22 days after planting	30	17
At 32 days after planting	31	24

Table 5. Dry matter yield, P concentration and P uptake of corn as affected by application of labelled cow slurry.

Cow slurry treatment	Dry matter yield	P concentration	P uptake
	g/pot	%	mg/pot
None added	2.88	0.23	6.58
125 g/pot, applied at planting	3.67	0.23	8.31
250 g/pot, applied at planting	4.21	0.29	12.08
125 g/pot, applied 1 week before harvest	2.80	0.23	6.27
250 g/pot, applied 1 week before harvest	2.79	0.22	6.17

Table 6. Specific activity of P in the plants.

Cow slurry treatment	$^{32}P/P$
	cps/µg
125 g/pot, applied at planting	19
250 g/pot, applied at planting	14

Table 7. Percentage of P in plants derived from cow slurry and estimated readily available P.

Cow slurry treatment	P derived from slurry	Readily available P	
	%	mg P/kg	% of total P in slurry
125 g/pot, applied at planting	46	30	4.3
250 g/pot, applied at planting	54	26	3.7

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Title and author(s)	Date January 1988
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Descriptors - INIS

COWS; FECES; FERTILIZERS; LABELLING; MAIZE; PHOSPHORUS 32; SOILS; SOLUBILITY; UPTAKE

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